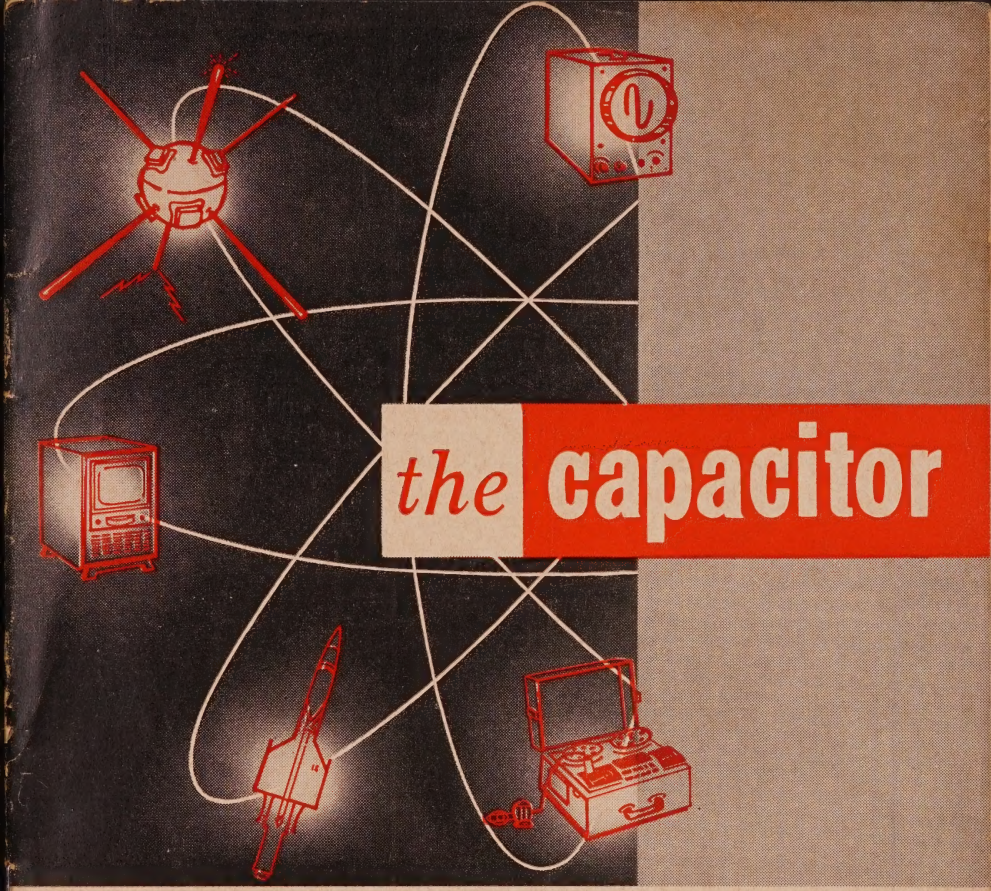

# the capacitor

CDE

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*Affiliated with* Federal Pacific Electric Company

SOUTH PLAINFIELD NEW JERSEY

**VOLUME 25 — NO. 1** **JANUARY - FEBRUARY 1960**

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**appearing in the**

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# POTENTIOMETER OPERATING DATA

A number of simple three-terminal devices are available to the electronic circuit designer. These devices are important in circuit development and testing, and are invaluable for performing such functions as voltage division, impedance matching, analog computation, stage isolation, filtration, and frequency selection. In addition, one three-terminal device, the transistor, provides amplification and can oscillate. Three-terminal devices are employed singly and in combination.

Some difference of opinion exists regarding the designation **three-terminal.** We apply this term to those devices which have three physical terminals; one input, one output, and one common. Some engineers insist that all input-output devices are four-terminal, and they may be in nature. However, it is easy to point out the difference. For example, a conventional transformer unquestionably is four-terminal, while an autotransformer is three-terminal in configuration.

It is impossible for a short article to cover all extant three-terminal devices, or all of the technical aspects of even a few of them. The purpose of this article is to point out the important operating characteristics of one of the most versatile of all such devices, the potentiometer, and to clear away some of the popular misconceptions held by technicians concerning its operation. We feel that the proper perspective will promote greater utility and more accurate operation of systems into which the technician frequently incorporates the potentiometer.

### D-C Potentiometer

The potentiometer is one of the simplest of three-terminal devices. Its common applications are voltage division, gain control, signal attenuation, analog computation, circuit balancing, and voltage comparison. Practical potentiometers are widely used

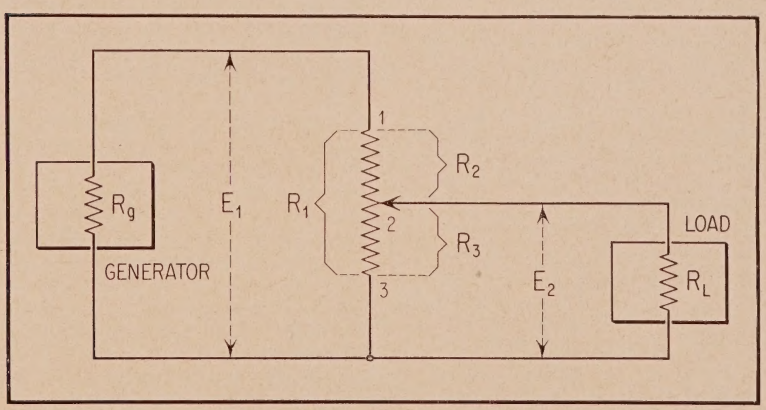


**Fig. 1. Practical Circuit of Potentiometer.**

in both continuously-variable and step types. In fact, there use is so common that many false assumptions are made regarding their operation and application.

Figure 1 shows the basic circuit in which the potentiometer is used. Operation of the potentiometer must always be considered with respect to its total resistance ($R_1$), the resistance between its top and wiper ($R_2$), resistance ($R_3$) between wiper and bottom, generator (source) resistance ($R_g$), and load resistance ($R_L$). It is common to suppose that the potentiometer divides the input voltage ($E_1$) by the ratio of $R_3$ to $R_2$ at any of its settings; that is, that $E_2 = E_1 (R_3/R_1)$. But this can be true only when $R_1$ is very high with respect to $R_g$, and $R_L$ is very high with respect to $R_3$ (say, 100:1 in each case). Otherwise, $R_L$ in parallel with $R_3$ will reduce the resistance between Points 2 and 3 to less than the value indicated by the potentiometer setting. The imput voltage ($E_1$) at Point 1 is reduced by the factor $R_1/(R_g + R_1)$. The error in the latter instance may be eliminated, of course, by actually measuring $E_1$ with a voltmeter. The voltage division is:

$$(1) \quad E_2 = E_1 \left\{ \frac{R_2 + \dfrac{R_3 R_L}{R_3 + R_L}}{R_g + R_2 + \dfrac{R_3 R_L}{R_3 + R_L}} \right\} \times \left\{ \frac{\dfrac{R_3 R_L}{R_3 + R_L}}{R_2 + \dfrac{R_3 R_L}{R_3 + R_L}} \right\}$$

A second misconception is that the output resistance (impedance), $R_o$, of the potentiometer is equal simply to the resistance included between Points 2 and 3 at any setting; that is, is equal to $R_3$. This could be true only if $R_g$ were very high with respect to $R_1$, which is almost never the potentiometer-generator relationship. Otherwise, the resistance looking back into the complete circuit must be the parallel combination of $R_3$ and the sum of $R_2$ and $R_g$, and this is less than $R_3$. Thus, the output resistance is:

$$(2) \quad R_o = \frac{R_3(R_2 + R_g)}{R_3 + (R_2 + R_g)}$$

This assumes that $R_L$ is very high and accordingly does not load $R_3$ appreciably.

It is important to note that the highest value of $R_o$ is reached when the setting (Point 2) is such that $R_3 = \frac{1}{2} R_1$. When the wiper is at the top of the potentiometer (Point 1), $R_o$ falls approximately to the value of $R_g$, when $R_1$ is much higher than $R_g$. And when the wiper is at the bottom (Point 3), $R_o$ falls to zero. Thus, if $R_1$ is a 10,000-ohm potentiometer winding connected to a signal generator having 50 ohms output resistance ($R_g$) and the load resistance ($R_L$) is very high (e.g., a vtvm, oscilloscope, or grid input of a voltage amplifier stage), the circuit output resistance, $R_o$, has the following values (from Equation 2): zero at Point 3, 2512 Ω at Point 2 (the midpoint of the potentiometer range), and 49.75 Ω at Point 1. Applying Equation (1) to the same example, we find, however, that the output voltage ($E_2$) at the midpoint of the potentiometer range (where $R_2 = R_3 = 5000$ Ω) still is approximately $\frac{1}{2} E_1$ when $R_L$ is assumed 1 megohm. (To be exact, $E_2 = 0.498E_1$.)

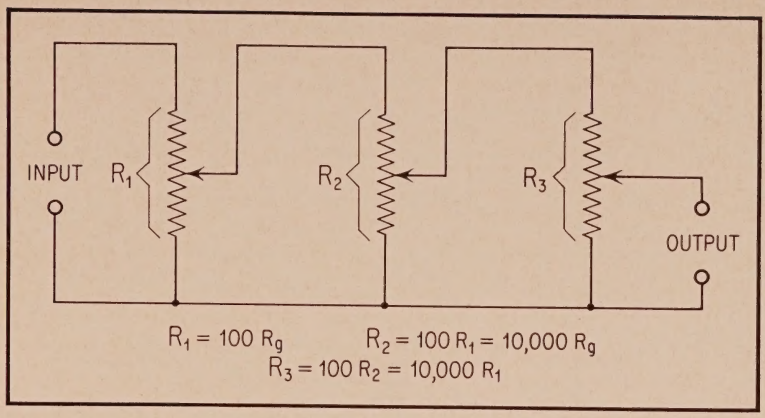


**Fig. 2. Cascaded Potentiometers.**

A third misconception is that the input resistance (impedance), $R_i$, of the potentiometer is the total potentiometer winding resistance, $R_1$. This could be true only if $R_L$ were extremely high so as to impose virtually no load upon the potentiometer. Otherwise, the resistance looking into the potentiometer must be the sum of $R_2$ in series with the parallel combination of $R_3$ and $R_L$ which will make $R_i$ less than $R_1$. Thus, the input resistance is:

$$(3) \qquad R_i = R_2 + \frac{R_3 R_L}{R_3 + R_L}$$

Again using the example of the 10,000-ohm potentiometer with a 1-megohm load, we can determine by means of Equation (3) that the input resistance, $R_i$, is 9901 Ω when the wiper is at the top (Point 1) of the potentiometer, and is 9975 Ω when the wiper is at the midpoint (Point 2) where $R_2 = R_3 = 5000\ \Omega$. If $R_L$ is reduced to 10,000 ohms, the value of $R_i$ when the wiper is at Point 1 drops to 5,000 Ω and to 8333 Ω when the wiper is at the midpoint.

The foregoing discussion and examples show in simple quantitative terms the importance of selecting $R_1$ high with respect to $R_g$, and $R_L$ high with respect to $R_1$. When potentiometers are cascaded, as in Figure 2, and their settings are to be read from resistance-calibrated dials, each successive potentiometer will introduce minimum loading error on the preceding one when its total resistance, $R_1$, is much higher than that of its predecessor. In the 3-potentiometer arrangement shown, $R_1$ is at least 100-$R_g$, $R_2 = 100R_1 = 10{,}000R_g$, and $R_3 = 100R_2 = 10{,}000R_1$. In practical systems where the resistance soon would become unwieldy, d-c amplifiers may be introduced between potentiometers for isolation.

### A-C Potentiometer

Simple potentiometer circuits may be employed in a-c circuits without modification and may be treated as

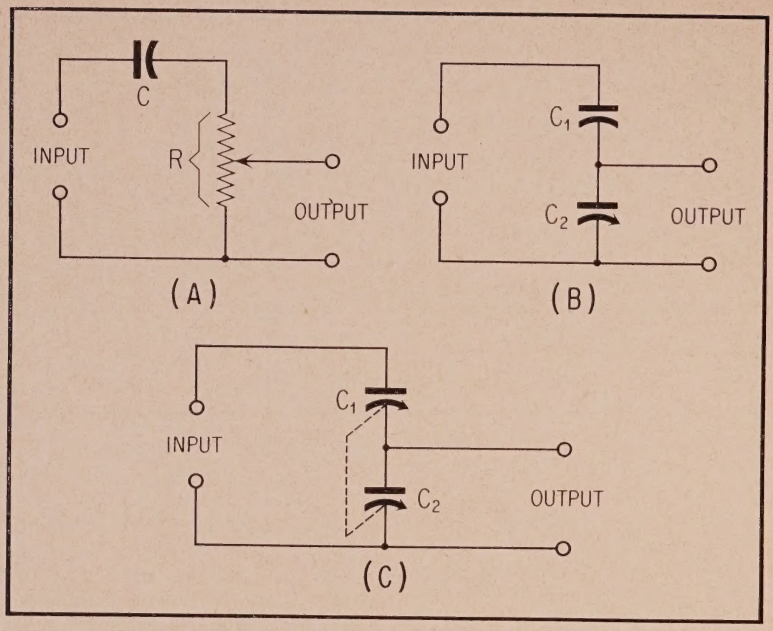


**Fig. 3. A-C Potentiometers.**

resistances when the potentiometers have negligible reactive components. High-resistance, wirewound units often have appreciable inductance, however, and the resulting impedance at the operating frequency accordingly must be taken into account.

In simple a-c circuits, the potentiometer often is connected in series with a blocking capacitor, as in Figure 3(A) for purposes of d-c isolation. When this is done, Capacitance C must be chosen such that its reactance at the operating frequency is very low with respect to Resistance R. This has a twofold advantage. The voltage drop across the capacitor is minimized, as also the phase shift introduced by RC combination. Thus, for 1000-cycle operation where R must be 0.2 megohm, C may be chosen 0.1 $\mu$fd. In this instance, the phase shift will be less than 1 degree and the attenuation better than 0.999.

Capacitive potentiometers are advantageous in some systems, especially at radio frequencies. The voltage division is proportional to the ratio of the reactances in the series string. Figure 3(B) shows one arrangement in which the imput capacitor $C_1$ (corresponding to Resistor $R_2$ in the resistive potentiometer, Figure 1) is fixed, and the output capacitor $C_2$ (corresponding to Resistor $R_3$) is variable. The fixed reactance of $C_1$ limits the maximum value of the output

voltage. Furthermore, the input impedance of the potentiometer varies as the setting of $C_2$ is changed.

Figure 3(C) shows a continuously-variable capacitive potentiometer which does not have the maximum-limiting disadvantage of the unit illustrated by Figure 3(B). In this circuit, a 2-gang variable capacitor, $C_1$-$C_2$, is so constructed that $C_1$ is at maximum capacitance when $C_2$ is at minimum, and vice versa. A constant value of input impedance therefore is presented to the generator. That is, the capacitance looking in from the input terminals is constant, while the output capacitance is variable.

Capacitance-type a-c potentiometers introduce a problem when they are connected to inductive generators or loads, since they form tuned circuits with these devices. Before selecting the capacitive elements for such potentiometers, the possibility of troublesome resonance at the operating frequency or its important harmonics

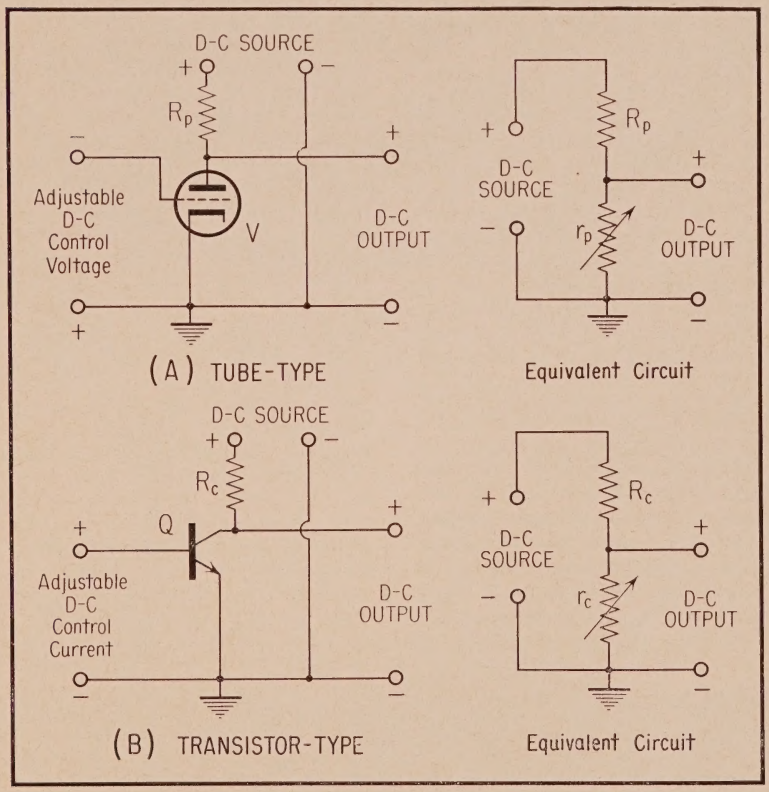


**Fig. 4. Active Potentiometers.**

accordingly must be investigated. Unlike their d-c counterpart, a-c potentiometers require shielding when they are used at frequencies higher than audio. At most radio frequencies, the shielding must be extensive and stray capacitances within the potentiometer must be eliminated or minimized.

### Active Potentiometer

By utilizing the variable output resistance of an active element (tube or transistor), an electrically-controlled potentiometer having high control sensitivity may be obtained. Figure 4 shows circuits of active potentiometers of the two types.

In Figure 4(A), the d-c voltage which is to be divided by the potentiometer supplies the plate potential of the triode tube, V, through the external plate resistor, $R_p$. The latter is in series with the internal plate-cathode resistance, $r_p$, of the tube, as shown by the equivalent circuit. An adjustable d-c voltage applied between grid and cathode, with the grid negative, varies $r_p$ from a high value (corresponding to grid cutoff voltage) to a low value (determined by the plate current flow which, in turn, is a function of the source voltage and $R_p$). If the external load resistance is very high with respect to $r_p$, the junction of $R_p$ and $r_p$ rises approximately to the source voltage, when the tube is cut off. When the tube is conducting, this junction voltage drops to a much lower value. When V is a high-transconductance tube, a small change in grid control voltage produces a large shift in resistance $r_p$. By reversing the control-voltage polarity, so that the grid is positive, large values of plate current ($i_p$) will flow, and the junction will fall to a still lower voltage, as a result of the drop, $i_pR_p$, across the external plate resistor, $R_p$.

In Figure 4(B), the d-c voltage which is to be divided by the potentiometer supplies the collector potential of the transistor, Q, through the external collector resistor, $R_e$. The latter is in series with the internal collector-emitter resistance, $r_e$, as shown by the equivalent circuit. An adjustable d-c current applied to the base-emitter circuit of the transistor, with the base of the NPN transistor positive, varies $r_e$ from a high value (corresponding to cutoff, when the control current is zero) to a low value (determined by the collector current flow which, in turn, is a function of the source voltage and $R_e$). If the external load resistance is very high with respect to $R_e$, the junction of $R_e$ and $r_e$ rises approximately to the source voltage when the transistor is cut off. When the transistor is conducting, this junction voltage drops to a much lower value. With a high-beta transistor, the control current will be only a few microamperes, and a small change in this current will produce a large shift in the resistance $r_e$.

The active potentiometer suffers from its in ability to be reduced to zero output resistance. The reason for this is that neither the tube nor the transistor can safely carry currents high enough to attain this state. However, resistances as low as a few tenths of an ohm may be reached with some transistors. Within its limitations, the active potentiometer is advantageous in automatic systems in which a small control voltage or current is utilized to control or stabilize operations of various sorts. Typical applications are voltage regulators, current regulators, automatic output attenuators, automatic and manual speed controls, temperature controls, light dimmers, and servomechanisms.

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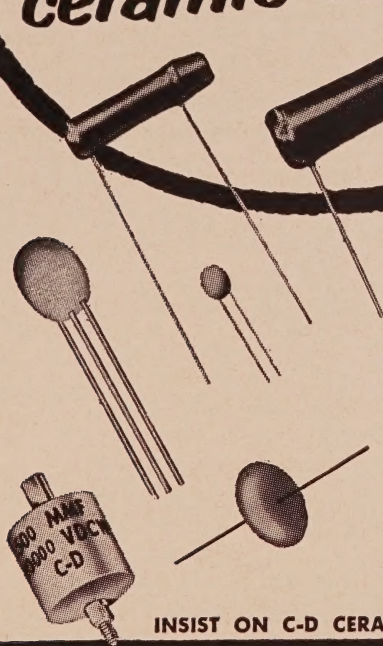


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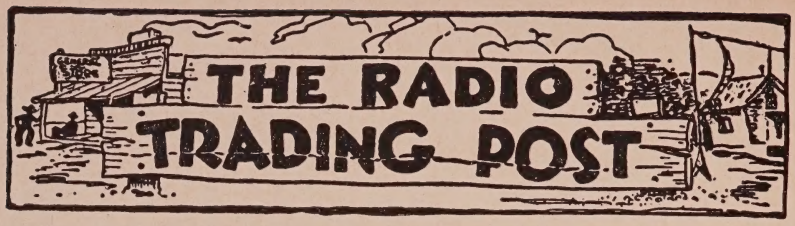


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**NEED** — Electronic test equip. by Hewlett-Packard, Gen. Radio, Tecktronix, Ballantine, L&N. Write prices on what you have. Altron Electronics, 409 East 7th St., Chester, Pa.

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**FOR SALE** — Collins TCS xmtr with extremely conservative power supply, best offer over $60; BC-1147A receiver, slightly modified, $60; T-23 xmtr, partially converted with home brew power supply, best offer over $35. Steven Fein, 162 12-14 Ave., Whitestone 57, N. Y.

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**WANTED** — Regency HF-350A 30 w. audio amplifier. State condition and price, write Martin Whitman, 154 Morton Blvd., Plainview, L. I., N. Y.

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**FOR SALE** — WA-P2 Heath pre-amp; RCA 36-A dot-bar gen.; Telematic substitute pix tube and speaker test unit; GR-118-S. Top bid on any or all. Gil Howarth, 216 1st Ave., East, Oskaloosa, Iowa.

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**SELL OR TRADE** — Magazines: Shortwave & Television, Radio & Television, Radio News, Radio News & TV, Radio Maintenance and Radio & TV Maintenance from March 1938 to September 1948, 10 cents each plus postage. Alexander Podstepny, 1652 Dounton St., Philadelphia 40, Pa.

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**FOR SALE** — B&W 370 SSB receiver adapter, $75; HQ-100C receiver, very good cond., $145; Elmac A54-H transmitter with 12 v. dynamotor and Gonset Super 6 converter, 12 v., $110, complete. T. K. Brown, 1111 Chenango St., Binghamton, N. Y.

**FOR SALE** — Pentron old model PTJ-3 tape deck, $10. Dave Overton, 1709 W. 30 St., Austin 3, Tex.

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**SELL OR SWAP** — Jensen 12" speaker, P-12-T standard series. Want fairly good 8-inch speaker. Charles K. Gabler, 1307 Merriam Ave., New York 52, N. Y.

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**FOR SALE** — Odds and ends of surplus manuals, some rare; relays, plate sensitive and telephone, teletype. H. E. Decker, 940 Lee St., St. Albans, W. Va.

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..**FOR SALE** — Sams unused #122 to 432, $1.50 each, Riders and Supreme radio manuals, test equipment. Send for list. Arnold Radio & Elec. Co., 2579 - 31st Ave., San Francisco 16, Calif.

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**TRADE** — Eico 249, 1. n., with probe. Interested in antique radio items. C. Fernandez, 81 Warren St., Roxbury 19, Mass.

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**SELL** — Pair RCA CM-5 citizen band transceivers, used once, all accessories, 6 v., 12 v. and both 115 v. AC, $200. M. Bardfield, 4 Brinsley St., Boston 21, Mass.

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**FOR SALE** — 1959 Heathkit DX-40 transmitter, professionally constructed, had two hours test time, loaded on all bands on first try, no other use, $75. Donald B. Briggs, 803 Black Hills Ave., Alliance, Neb.

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**FOR SALE** — QST past issues, ARRL Handbooks, IRE Proceedings, DC milliammeters, microammeters. Want small scope with direct connections to deflection plates. Carl Drumeller, 5824 N.W. 58th St., Oklahoma City 12, Okla.

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**SELL OR SWAP** — V-6 Heathkit VTVM and Knight in-circuit capacitor checker, with books; need 6-12 v. DC power supply. Harold Gauthier, Box 394, Cottonport, La.

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**FOR SALE** — Jackson 641-A Universal sig. gen., with cable and inst. book, very good cond., $50; Riders 1-15, make offer. Val Obal, 3201 So. 73rd St., Omaha 14, Neb.

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**FOR SALE** — To highest bidder: like new Eico 6 v. and 12 v. battery eliminator and charger; Sams auto receiver manuals 2 and 3, and Communications rcvr manual. Ralph Landers, 6446 Lexington Ave., Hollywood 38, Calif.

**WANTED** — Unbroken inked code practice tapes for TG-34A keyer — straight text only, no code groups. George W. Miller, 3111 McNeel Rd., San Antonio 1, Tex.

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**FOR SALE** — DuMont 224-A 3" scope, looks nice and works well, $40 FOB. Brian J. Desind, 2458 Shirley Avenue, Baltimore 15, Md.

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**SELL OR TRADE** — Simpson Giant set tester, model 320. Glen Johnson, Box 96, RFD 3, Seymour, Tenn.

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**TRADE** — High dissipation transmitter tubes and surplus parts, for Sams and Riders. A/2C Joaquin A. Araujo, Box 2011, James Connally A.F.B., Tex.

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**SWAP OR SELL** — 1911 Colt U.S. 45 automatic, with new barrel, $25 FOB. Need 151 to 174 Mc. FM receiver, 110 v. AC. G. D. Griffin, 322 W. State, Ithaca, N. Y.

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**SELL OR TRADE** — JBT 30F freq. meter, 10 reed 48-62 cy. per second, $13 postpaid or trade for Hallicrafters S meter kit, or make offer. Carlos A. Duharte-Francia, 3702 Logan Ave., Fort Wayne, Ind.

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**FOR SALE** — RCA desk mike, $10; 1/4 hp. AC motor, $10; want Theremin, multitester, tube tester. Keller, Memory Lane, Linlithgo, N. Y.

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**SWAP** — CRT tester-reactivator, like new. Want 12 v. car radio to fit 1959 Chevy., or jigsaw or saber saw in good cond. Seymour Schwartz, 115 Hamlet Road, Levittown, N. Y.

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**TRADE OR SELL** — SX-25 rec., $45; Emerson 2001 table radio, $10; transformers 300-0-300-5-6 v., $2.50; Eico 221 VTVM, $18. Want low-power CW transmitter. D. Weber, 136-42 Maple Ave., Flushing 55, L. I., N. Y.

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**FOR SALE** — Heathkit 0-8 scope; TV align. gen. TS-3, fine cond.; encylc. on scope uses, Rider and Uslan; instr. booklets on TV service techniques, all for $60. Samuel P. Fiore, 7 Stone St., Danvers, Mass.

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**WANTED** — Abbot TR-4 transceiver in good cond. Will trade or sell Heath BR-2 receiver in good cond., no cabinet. Joseph F. Dineen, 9 Winter Terr., Westwood, Mass.

**SELL OR TRADE** — Altec Lansing 601 15" Electro-Dynamic speaker with supply, in very good cond. Make offer. H. B. Haftel, 1555 Inwood Ave., Bronx 52, N. Y.

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**WANTED** — Transformer input, 80 - 130 v., output, 80 - 130 v., at least 10 amps. output. John Burkhart, 13182 Mercier, South Gate, Mich.

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**WANTED** — Good used TV tuner for Olympic TV 1KA80-U, also good used 12 w. amplifier with TV jack. John Dixon, 4120 Everett St., S. Norfolk 6, Va.

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**FOR SALE** — Heath: OM-2 scope, $35; SG-8 sig. gen., $15; TS-4A align. gen., $45. All like new. Earl Korstick, 628 Primrose St., Anaheim, Calif.

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**WANT TO SELL** — Radio and ignition business, here 13 years, good stock, will sell at about your own price or will just sell stock. Come look — make offer. Harvey L. Nostrand, B&C Ignition Service, 3 London St., East Greenwich, R. I.

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**SWAP** — Radio gear and 8 mm movies. My list for yours. W. M. McDonald, 25A Crescent St., Lawrence, Mass.

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**WANTED** — Late model tube tester and communications receiver, with BC band. Receiver need not be in perfect working condition but repairable, give all data. B. Rutkowski, 5030 Walsh Ave., East Chicago, Ind.

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**FOR SALE** — Presto 3-speed T-15 turntable, $30; University 612 speaker, $50; Heathkit A-9C with added mixers and Scott variable equalizers, all very good cond., $30. Richard James, 501 East Daniel, Champaign, Ill.

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**FOR SALE** — Matched pair Vocaline cit. band xcvrs., base antenna, DC and AC cables, mobile ant., value $180. Also Eico 625 and 666 tubetester, very good cond., make cash offer. J. J. Mueller, Manchester, Vt.

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**WANTED** — NRI or Christy Elec Appliance Repair course; DeVry or RCA TV Repair course. State prices. G. R. Parshall, R.D. 2, Sherburne, N. Y.

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**FOR SALE** — Basic Math for Elect. Radio & TV by Singer, $3. L. Matushefske, 2 Elmont Rd., Elmont, L. I., N. Y.

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**SELL OR SWAP** — Magnovox Hi-Fi AM-FM receiver coupled with 12" and 5" speaker; Philco AM-FM 14" TV; RCA 12" TV. Need Riders TV manuals, Seco or Sencore grid circuit tube tester. R. Rivet, 64 Breslin Ave., Cohoes, N. Y.

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**FOR SALE** — Eico 625K tube tester, wired, good condition, with pix tube adapter, $25. O. L. Bremer, 2858 Blue View Dr., Redding, Calif.

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**WANTED** — Grid dip meter. State price and condition. E. J. Luck, 57 E. Buttonwood Ave., Pine Hill, N. J.

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**FOR SALE** — Back issues of Electronic Technician, Mar. 1958 to Sept. 1959, minus schematics, like new, $5. David McCreadie, 631 So. Main St., Woonsocket, R. I.

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**FOR SALE** — Thordarson T19F99 fil. transformer; Sola 30804 constant voltage transformer; Radiola 33, no speaker, working, schematic; RCA 106 speaker, 10", own power supply., dual selenium rectifiers, in very good working order, schematic, $5 each plus postage. R. W. Downs, 5101 - 39th Ave., Long Island City 4, L. I.

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**FOR SALE** — CE 20A, used 2 hours, $150; VFO, $38; Gonset 500 w. linear, like new, $150. A. R. Dayes, 29 Charles St., Merrick, L. I., N. Y.

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**FOR SALE** — DX-100 in fine condition, not marred or scratched, $150. L. M. McGee, 58 Campus Dr., No. Buffalo 26, N. Y.

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**WANTED** — Organ parts (electronic) to swap or buy. Have CREI course, electronic parts, 17" GE portable TV. Arthur G. Dunchock, 12905 Evergreen, Detroit 23, Mich.

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**FOR SALE** — Must sell complete radio service equipment, 11 years of tool accumulation, VOM, signal gen., signal tracer, $150. Joseph Diorio, 7350 Oriole, Chicago 48, Ill.

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**SELL** — BC-348 modified AC power supply, $65; PE-103 dyn. cables, $8; Newcomb amplifier 30 w. tubes AC, $20; BC-454, needs minor repair, $5. E. L. Nicks, R. 1, Box 169-C, Dubuque, Iowa.

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**SELL OR TRADE** — Wallace Telaides. Send for list. RCA 45 recorder changer, needs needle. Frank Mordini, Highwood, Ill.

**FOR SALE** — Webcor 80-1 wire recorder; GE Musaphonic 78/33 auto. turntable with 2 plug-in heads; Intercom with 2 subs. All in good cond., best offer. Scott Wood, 105 Luckie Lane, Media, Pa.

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**WANTED** — Heathkit sig. tracer, 5AXP4 and 8AXP4, any cond.; wind-speed and wind direction indicator, by Taylor; CRT Model RE-1 rejuvenator. State price, cond., age. J. Kozma, 12450 N.W. 5th Ave., Miami 68, Fla.

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**SELL** — Century 201 RC tester, fine cond., $14.50; Quam 5¼" speaker electro-dynamic, $2.25; VOM 20,000 opv., Knight wired and working cond. Best price over $20. J. Luciano, 90 Columbia Avenue, Newark 6, N. J.

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**WANTED** — Power transformer for DuMont 241 scope. C. Knudsen, 1194 Murray Dr., Jacksonville 5, Fla.

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**SELL OR TRADE** — 1917 Yearbook of Wireless Telegraphy and Telephony (over 1,000 pages); Simpson 260 voltmeter; misc. Weston meters; U.S. mint plate block collection (approx. 400 blocks). Want Polaroid Land camera, or ?? Harry Gursh, 148-37 - 90th Ave., Jamaica 35, N. Y.

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**WANTED** — Tung-Sol radio tubes 6SD7 GT., $.60 each plus postage. L. Z. Keene, 309 Mark Hannah Pl., Ann Arbor, Mich.

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**SWAP** — Gilbert electric drill; Eifel geared adj. wrench for Eico signal tracer; M.F. bench vise; snap lock wrench; set of tap and dies for Sencore LC checker. Local only. Irwin Kamner, 1951 Elston St., Philadelphia 38, Pa.

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**FOR SALE** — Rider TV manuals 1 thru 6; Radio manuals 10, 11, 12. Make offer. Radio, TV and electronic tech books, $1 and $2, or 10 books, $10. W. J. Stack, R. 1, Delmar, Iowa.

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**FOR SALE** — Last five years "Audio" magazine minus 2 issues, $15; 1952 issue of CREI course II, $20. Add shipping charges. C. R. Chastain, 33 Nottingham, Brunswick, Ga.

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**FOR SALE** — Eico 556 VOM, perfect, $12; pair Rayco antenna coils, $9.50; Astatic AT1 TV booster, $8; tubes — 810, 815, (3)75TL and filament xformer; xmitting condensers, meters, parts. J. E. Farrier, 222 Johnston Circle, Sidney, N. Y.

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**FOR SALE** — R.T.I. radio and TV course, less kits, $25 prepaid. Prefer local. G. Hibler, 85 Navy Walk, Brooklyn, N. Y.

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**WANTED** — Public address systems; amplifiers with phono attached; outdoor type loudspeakers. Write details and price. H. Eller, 150 Broadway, New York, N. Y.

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**URGENT** — Need pair citizen band transceivers, accessories, for cash. S. Krzak, 65 Main St., Pawtucket, R. I.

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**FOR SALE** — Heathkits, electronic equip., audio amplifiers, meters, radios. Send for list. Johnnie, 8561 66th Rd., Forest Hills 74, L. I., N. Y.

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**SELL OR SWAP** — NRI course; Heathkits; AT-1 CW xmitter, VFO; RCP AM sig. gen. and multimeter; CW xmitter (1625 final); Argus C-3 w/flash attach. Want scope, guns. William H. Gibbs, 249 So. Pugh St., State College, Pa.

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**FOR SALE** — PM-35 dynamotor and BC-659 transceiver. Bruce Swearingen, 47 Ridgelawn Rd., W. Asheville, N. C.

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**FOR SALE** — Zenith Cobra pickup oscillator unit; antique TV disc; novice transmitter and receiver with instr.; kilowatt power supply; excellent citizens band freq. meter BC-221-AL. G. Porter, 315 Swan Ave., Allegan, Mich.

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**WANTED** — Amateur radio communications receiver, single or dual conversion, with or without speaker, in good working condition, later model preferred. State particulars. D. Landesberg, 179 Marcy Ave., Brooklyn 11, N. Y.

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**WANTED** — Instruction manual and/or schematic for Supreme 561 sig. gen. State price. William Ungvarsky, Ames 312, Cambridge 38, Mass.

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**FOR SALE** — Beckman Ph meter, battery operated Model M, Serial #4339, in carrying case for technical use. Mfgd. by National Tech. Labs. $25 FOB N. Y. Henry Ganz, 236 - 8 Ave. N.E., St. Petersburg, Fla.

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**FOR SALE** — Hallicrafters S-20R SW rcvr. Fine for SWL's, $15 FOB. B. D. Muench, R. 11, Box 599A, Lemay 23, Mo.

**SELL OR TRADE** — DX-35, $40; Heath VFO, $15, both in fine condition, or trade for radio control equip. Roland Jennings, 302 E. Pioneer, Shenandoah, Iowa.

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**SELL OR TRADE** — Transtat, type TH, ganged, 0-115 v., 60 cy., 100 amp. rating; transformer — primary 110 v., 60 cy., secondary 25 to 30 Kv at ½ amp. plus. About 500 lbs. R. A. Hostetler, 2556 No. Lake Dr., Milwaukee 11, Wis.

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**FOR SALE** — Proceedings of the IRE from May 1954 to present, fine condition, make offer plus shipping. Peter Luedike, 24 Quintard Dr., Port Chester, N. Y.

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**FOR SALE** — Thirteen perfect 100 cycle synchronous 12-volt vibrators, Electronic Labs. Inc., type R-79-E, with 7 prong bases. Gerard A. Baldauf, 3137 Philmont Ave., Huntingdon Valley, Pa.

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**FOR SALE** — Audio generator, Heathkit AG-8, $19; 1956 and 1957 copies of Radio and TV News and Radio Electronics and 1958 copies Popular Electronics, 25 cents each. D. Powell, 178 Pinckney Rd., Little Silver, N. J.

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**WANTED** — AM-FM tuner, local only; Golde-Heiland, 35 mm C-99 blower adapter with lens for 3¼ x 4 Master projector. J. Arthur, 7641 N. Ashland, Chicago 26, Ill.

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**WANTED** — Cathode ray tube for Sylvania 7GP1 scope. State price and postage. Harold Gerson, 15707 Eastwood Ave., Lawndale, Calif.

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**SELL OR TRADE** — 20 cameras, subminiature to 4 x 5, for communications receiver, marine radio telephone, depth finder, test equipment. Ed Videika, 33-40 89th St., Jackson Heights 72, N. Y.

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**TRADE** — Slide rule, Hemmi- chemical-engineers duplex No. 257, in very good condition with manual. Front: L, A, DF, CF, CIF, CI, C, D, LL3, LL2, LL1; rear: 12 chemical scales. Want Post Versalog No. 1460 with manual, or other fully mathematical rules. Ray Parker, 315 Broadway, Kingman, Kan.

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**FOR SALE** — Fairchild pre-amp, amplifier and cartridge; Harmon Kardon AM-FM tuner; Goodman speakers and cabinet for above equip. Also expensive Webcor changer. Best offer for all or part. T. Gavin, 36-35 167th St., Flushing 58, N. Y.

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**FOR SALE** — 5UP7 CRT with metal shield and Bezel, best price over $18; (2) 3JP-1 CRT, $4.50 each. All FOB. M. Schwartz, 143 Kendall Road, Franklin Park, N. J.

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**WANTED** — Service manual for Bendix 2-way radio, MTR-10-AD-3, Serial #1-55. Robert E. Poleet, Box 62, Jerseyville, Ill.

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**WANTED** — Precision E-400 sweep signal generator, in good cond. Louis Tonik, 1204 Passmore St., Philadelphia 11, Pa.

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**SELL OR SWAP** — Riders Radio manuals, 1-14, good cond. Make offer or trade for good used tape recorder. Leonard H. Robarge, 309 W. Lytle St., Fostoria, Ohio.

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**WANTED** — Circuit diagram of Navy low frequency regenerative receiver, RAK-7, W.W. II vintage. Floyd Donbar, 6305 Flushing Rd., Flushing, Mich.

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**FOR SALE** — RG11/U coax like new, 5 cents per foot lengths over 100 ft.; several RCA type TMV-129B xtal ovens approved for broadcast xtal holders. Price on request. Fred L. Kost, 431 Flamingo St., Philadelphia 28, Pa.

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**SELL** — Webcor "Royal" Stereophonic tape recorder, $175, like new, original carton. Want 810's, 811's, RK65's, 5555, 4-125A, 304TL tubes. Rosellini, 2619 So. Gaylord, Denver 10, Colo.

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**FOR SALE** — Complete contents Radio and TV repair shop: Sams and Riders, Hickok, RCA, and Precision equip., RCA and Sylvania tubes, etc. Send for list. M. Raffer, 9 Weldon Lane, Plainview, L. I., N. Y.

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**SELL OR TRADE** — DX-35, $45; 755A - VFO factory w/t, $50; Johnson Signal Sentry, $15; Blitz Bugs, $4 each; HRO-5 with coils and power supply, $75; Instructograph, AC with 12 tapes, $35. Want mobile xmtr. W. L. Patterson, 2161 - 23rd Ave. N., St. Petersburg 13, Fla.

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**WANTED** — Plugboard for IBM collator, interpreter, or reproducing punch. Prefer local. Steve Gray, 60 West 85th St., New York 24, N. Y.

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**FOR SALE** — 5820 image Orthicon deflection yokes, with slight defects, $5 each; two 6-volt Carter dynamotors, $3 each or both for $5. H. Gordon, 325 Morgan Ave., Old Bridge, N. J.

**TRADE** — 16 vol. CREI course, like new cond. Trade for signal tracer in good cond. G. Stutzman, 450 Hibiscus Lane, Dunedin, Fla.

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**FOR SALE** — National NC-240-D receiver. Want Command set SCR-274N components. Molyneux, 4551 Shadesview Dr., Mobile, Ala.

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**WANTED** — Alprodco aluminum tower or tower sections. Joseph Nester, Rich Valley Rd., Emporium, Pa.

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**FOR SALE** — Radio Craftsman TV tuner and amplifier, chrome chassis; Mattison 630 TV chassis with 31 tubes; Sutco converter and booster; books; parts; tubes. Lyle Parks, 3327 West 27th St., Bradenton, Fla.

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**WANTED** — Sweep generator, Heath TS4, or other reasonably priced type. E. E. Bensen, 1006 Prairie, Joliet, Ill.

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**WANTED** — FM radios and tuners. State model, condition and FOB price. Mercury Radio, 433 South Wabash Ave., Chicago 5, Ill.

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**WANTED** — Radiola I; other radio gear prior to 1925, such as Grebe CR-18, Kennedy 281, Atwater-Kent Breadboard, DeForest receivers, tubes, parts, and magazines prior to 1923. Paul Giganti, 2429 San Carlos Ave., San Carlos, Calif.

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**WANTED** — VTVM, 2 or 3% accuracy, DC and R ranges essential, Convair, HP or GR equivalent, for cash or trade. C. Osiecki, 69-10 Ditmars Blvd., East Elmhurst 70, L. I., N. Y.

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**WANTED** — Riders TV manuals 15 thru 24, all or part. State lowest price. Modern Electric, 111 Main St., Waterville, N. Y.

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**TRADE** — Large accordion from Milan, Italy, for Hi-Fi equip. Accordion in fine condition musically, needs straps only. Want combination amplifier and preamp., AM-FM tuner, Garrard automatic changer, complete or tape recorder. John J. Custer, 44-55 Kissena Blvd., Flushing 55, N. Y.

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**FOR SALE** — Metal detector Goldak Radioscope, cost $200, used little, contains transmitter and receiver, handles and instructions, first-class shape, factory built, $45 plus express charges. John H. McHocko, 205 S. 11th St., Easton, Pa.

**FOR SALE** — RCA 10 w. 450-470 Mc, crystal controlled FM receiver-transmitter complete with mike, controlhead, cables, spkr., and antenna, $75. Fred J. Engelbrecht, R. 6 and Dye Ave., East Paterson, N. J.

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**FOR SALE** — Viking Valiant transmitter, factory wired, new tubes, and in fine condition. Send offer to J. R. Little, Elwood, Ill.

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**FOR SALE** — Bendix marine radiotelephone — 6 channels and broadcast, Skipper model 45, 50 watts, 12 v., used slightly, $225. William J. Tarrant, 213 So. Porter St., Saginaw, Mich.

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**WANTED** — Used and repairable tube checkers, scopes, VTVMs, up to 8 yrs. old. Describe for cash offer. P. J. Vogel, 3328 Caroline St., St. Louis 4, Mo.

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**SELL OR TRADE** — Equipment and material for manufacturing frequency control crystals for xmitters and receivers. Includes new planetary lapping machine in original crate. D. F. Williams, Municipal Airport, Bartlesville, Okla.

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**FOR SALE** — Professional quality Magnecord 101 stereo tape recorder in portable case, unused, in orig. carton, $350 FOB. Ken Massey, 3449 Winthrop Avenue, Indianapolis 5, Ind.

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**FOR SALE** — Simpson 488 TV field strength meter, like new. Best offer. R. O. Bruner, R. 4, Terre Haute, Ind.

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**SELL** — Essco deluxe citizen band transceiver, with mike and power supply, $25. Bro. Augustine Schmidt, St. Meinrad Archabbey, St. Meinrad, Ind.

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**WANTED** — For cash — Good used ion trapcoil (not fixed magnet), and electrodynamic speaker, for RCA 630TS TV receiver. G. W. Field, 2634 Bryant Ave. South, Minneapolis 8, Minn.

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**FOR SALE** — Magnovox AM-FM chassis, $25; Eico FM tuner, $50; Heath: WAP2 $20, UA2 $25, FM-3A $30; photocell relay meters, $10 each; 2-speed changer, $10. All prepaid. F. W. Preeshl, 76 Prospect Blvd., St. Paul 7, Minn.

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**WANTED** — 14C7, 50A5 and 5Z3 receiving tubes to be in good condition. State quantity available and price. E. Morgan, 561 - 41st St., Brooklyn 32, N. Y.

**FOR SALE** — Hickok sweep 610A, in good working cond., $65; Eico VTVM, $15; Ebco CRT checker-reactivator, $6; Nilsons Master course in radio communication, like new, $40. Thomas Diehl, 4 Jackson Ave., So. Glens Falls, N. Y.

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**WANT** — Good 3" scope, also complete projection TV rcvr with Phillips (Norelco) condensing system for cash, or trade GE 810 TV receiver, needs alignment, and Motorola 12VK11R TV rcvr with new pix tube. M. B. Rotnem, 722 Allerton, Kent, Ohio.

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**FOR SALE** — FM Pilotuner in fine cond. with spare tubes, $15. Local only. J. J. Wohl, 1967 Ocean Ave., Brooklyn 30, N.Y.

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**FOR SALE** — Simpson 215 VOM; Electronic Design VTVM; Premier signal generator; RCA 45 record player; used original 63D tuner. T. Popel, 1223 Elm Ave., Brooklyn 30, N. Y.

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**FOR SALE** — Like new Seco GCT-5 grid circuit tube tester, with instruction manual, $15 postpaid. Joseph F. Lacinak, 1579 Wellington Ave., Youngstown 9, Ohio.

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**FOR SALE** — Heathkit TS-3 TV alignment sweep and marker generator in good cond., complete with 4.5 Meg. crystal and operating instruction manual, $30. Stanley Caldwell, Natural Bridge, N. Y.

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**SELL OR TRADE** — Communications receiver: 5-band, 9-tube single conversion super-het, very fine vernier dial drive mechanism, audio filter, BFO, tuning eye, stand-by, phone jack, speaker, steel case. A. G. Soderlund, 4001 Mt. Barnard Ave., San Diego 11, Calif.

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**WANTED** — Service manuals on RCA and Motorola 2-way mobile equipment — BC-453. E. L. Felder, Tylertown, Miss.

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**SELL OR TRADE** — 13 copies of Radio-TV News; 54 copies of Radio Electronics; 35 copies of Service; 8 copies of Technician; 50 copies of Radio Service Dealer; 44 copies of PF Index. Cash or trade for test equip. Cheri's TV, 1865-15th St., Wyandotte, Mich.

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**FOR SALE** — 200 ft. trap dipole wire and 110 ft. coax, 25 w. CW xmtr. 80-40 tubes, 3 crystals, AC power supply 300 v. @ 125 ma., 6.3 v. @ 3.5a, TR switch, 829B, 807. Robert Sherman, 8871 - 20 Ave., Brooklyn 14, N. Y.

**TRADE** — Heath VTVM V-7A, DB-20 preselector, VHF ARC-5 xmtr., for good 12 v. factory mobile converter; S-76 Hallicrafter, HF ARC-5 xmtr., components for complete 1500 v., 300 ma. power supply, for 12 v. Elmac. Many extras included for postage or sell for best offer. Emil Kalar, Box 221, South International Falls, Minn.

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**BUSINESS FOR SALE** — TV sales and service, and home combined, all the service business you want, fine town of about 7500 population. Not necessary to buy stock. Not in California. W. J. Wyatt, 3166 Gale Ave., Long Beach 10, Calif.

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**FOR SALE** — Gonset G-66-B with power supply, Elmac AF-67 with James 3-way power supply; Dow-key relay with 6-110 v. coil, Shure type mike with F-1 unit, Slim Jim all band ant., instruction books and extras, $325. Myron Pickett, 602 12th Ave., Green Bay, Wis.

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**FOR SALE** — B&W 1 Kw. antenna coils 80, 40, 20 and 10 HDA and jack bar, $25; Johnson SWR bridge 52 ohm, $7; Hickok 288X sig. gen., $120; Eico 425 scope with calib., $40. Dan Stevens, 34 Yale Square, Morton, Pa.

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**WANT** — 16 mm sound projector of type that uses sprocket movement, not claw. Cash or trade. D. W. Sheldon, 215 Grant St., Salem, N. J.

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**WANTED** — Regency ATC-1 amateur band converter in good cond. Geo. Demaris, WINK-TV, Fort Myers, Fla.

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**FOR SALE** — 17" TV table model, new pix tube, $25; 16" TV custom, console, 630 chassis 10" speaker, $25; 12½" TV table model, $20. All in very good working condition. Thomas Dolan, 16 Foster Ave., Valley Stream, L. I., N. Y.

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**FOR SALE** — Hallicrafters S40A receiver, very good cond., tunes down to 44 Mc., $49.50. B. Nastoff, 320 W. 56th Place, Gary, Ind.

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**FOR SALE** — Heathkit DX-40, like new — offer, checked by comm. station engineer. Will trade if reasonable. Mark D. Pallans, 30-46 35th St., Astoria 3, N. Y.

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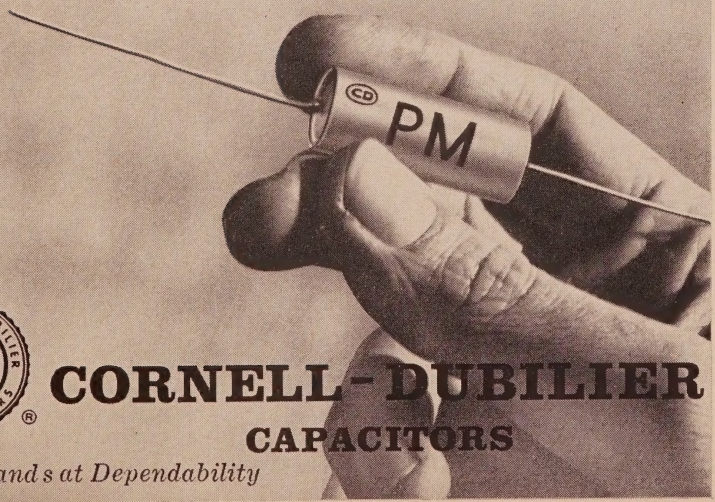
**WANTED** — Used NRI radio course or air conditioning course with or without kits. Russell N. Trowbridge, 3841 Indiana, St. Louis 18, Mo.

*take the C-D type "PM" MYLAR tubular for instance . . . it's the last word in dielectrics. And C-D is first again with the best for service replacements.

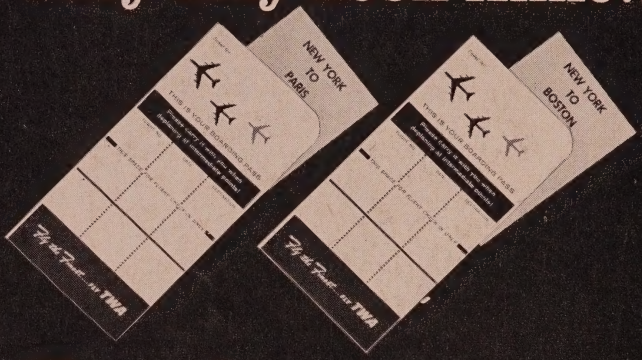
# to do the best job use the best*




CORNELL-DUBILIER CAPACITORS

*Old Hands at Dependability*

# They May Look Alike...




## But what a difference!

It's the same with capacitors. Others may look like C-D miniaturized electrolytics, but only C-D's have the built-in extras that are the result of 50 years of capacitor leadership. Next time you buy capacitors, insist on performance. Insist on C-D... *by name!*

### TYPE NLW (ELECTOMITE)

Hermetically sealed into an *ultra-small* aluminum can, this aluminum foil tubular has *welded* terminal connections to insure long-lasting performance. It is ideal for transistorized and printed circuits.

**There are more C-D Capacitors in use today by far — than any other make.**

*Don't gamble — specify C-D*

CDE **CORNELL-DUBILIER CAPACITORS**

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